Rapid results with robust design

International Symposium on Robust Design
Copenhagen, 14th - 15th August 2014

Søren Bøgvad Petersen, sqbp@nnepharmaplan.com
Torben Bygvraa Rasmussen, tbbr@nnepharmaplan.com

Everybody wants robust product design

- Because robust design – that is insensitive to variation in components – is the key to lowering costs and quality issues

- But to get there you must be able to
  - Evaluate the robustness of your design
  - Optimize the design

- Many producers find it difficult to “get started” – especially in a way, where results can be demonstrated fast

Obtaining rapid results with robust design

In our experience one path to rapid results is

- To involve the right people from the start
- To choose an easy-to-access and flexible software

Enables

Enables

Focus of this presentation

Use easy-to-access & flexible software
VarTran® (Variance Transmission)

VarTran is a software tool that allows for

- Setting up a tolerance analysis (I/O system)
- Making realistic assumptions on input variation
- … yielding realistic predictions of output performance
- Optimizing target values to obtain robustness in product functionality

Use easy-to-access & flexible software
5 steps to get results with VarTran

The basic procedure to get started with VarTran is

1. List the critical outputs (Y's)
2. Enter specifications for the output
3. List the critical inputs
4. Enter the relationship between inputs and outputs (analytical transfer function)
5. Define capabilities and assumptions for the inputs

1

3

4

2

5

Use easy-to-access & flexible software
Applied to a client case – welding (problem statement)

- Welding of (red) rubber plates to (white) injection moulded part:

Customer had decided to weld in the middle of the welding area on the injection moulded part

- Problem of bad welding due to part- & process variation:

BAD welding

Use easy-to-access & flexible software
Applied to a client case – welding (procedure)

If OK, Done

Use easy-to-access & flexible software
Applied to a client case – welding (results)

- Accounting for part variation (in the right way) a realistic modelling of the output variation was obtained

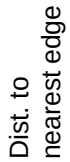
Error rate on a bad day = 89%

- The most robust solution was a target optimization (moving welding position) and not an optimization of process performance

Old position

New position

Management support obtained because of fast start-up and rapid results (2 weeks)



Welding position

Error rate on a bad day < PPM

Use easy-to-access & flexible software

Excel used for custom solutions

- Customized Excel tool for tolerance sensitivity analysis
  - Output results fit on a single page (easy copy/paste for presentations)
  - Sensitivity on inputs and simulated output along with “VarTran”-like output

SPEC

OUTPUT

GRAPHICAL OUTPUT

Use easy-to-access & flexible software
Excel used for custom solutions

- Systematic administration of equipment- and product approval specifications

Specifications
Short term variation

Specifications
Long term variation

- Customized method for tolerance analysis calculation
  - Differentiate handling of e.g. linear sums and RSS sums

- Multiple problem types
  - Tolerance stack analysis (mass balance) on an API production line
  - Mechanical property product optimization

Adaptable to customer needs and suitable for multiple problem types
and importantly to match actual distributions on tolerance stack inputs
to ensure reliable prediction of product failure rate

Part specifications

Why are input distribution assumptions so important?

Device R&D makes ASSUMPTIONS on part variation to ”guarantee” functionality

Specifications*

If ”Production” complies with assumptions = predictable functionality

Data feed back can not be applied

PPM

Diameter Pin | Diameter Hole | Clearance

Avg. dim. on target => Designed Clearance

PPM

Reality:

%?

Avg. dim. Never on target => clearance?

The ”common language” between R&D and Production are specifications

If specification do not Reflect R&D assumptions there is a risk that the product does not behave as predicted on the marked

If assumptions are violated = device function failure rate is not predictable

C_{pk} is ambigous

Centering metric needed: C_c

No ”common language” = Unclear communication!

Unclear communication = Learning & Improving is difficult!

*): Specifications= Tolerances & statistical requirement to fulfill them.

LSL Target USL

LSL Target USL

Vital elements for obtaining rapid and reliable results with robust design

Enables

Thank you for your attention